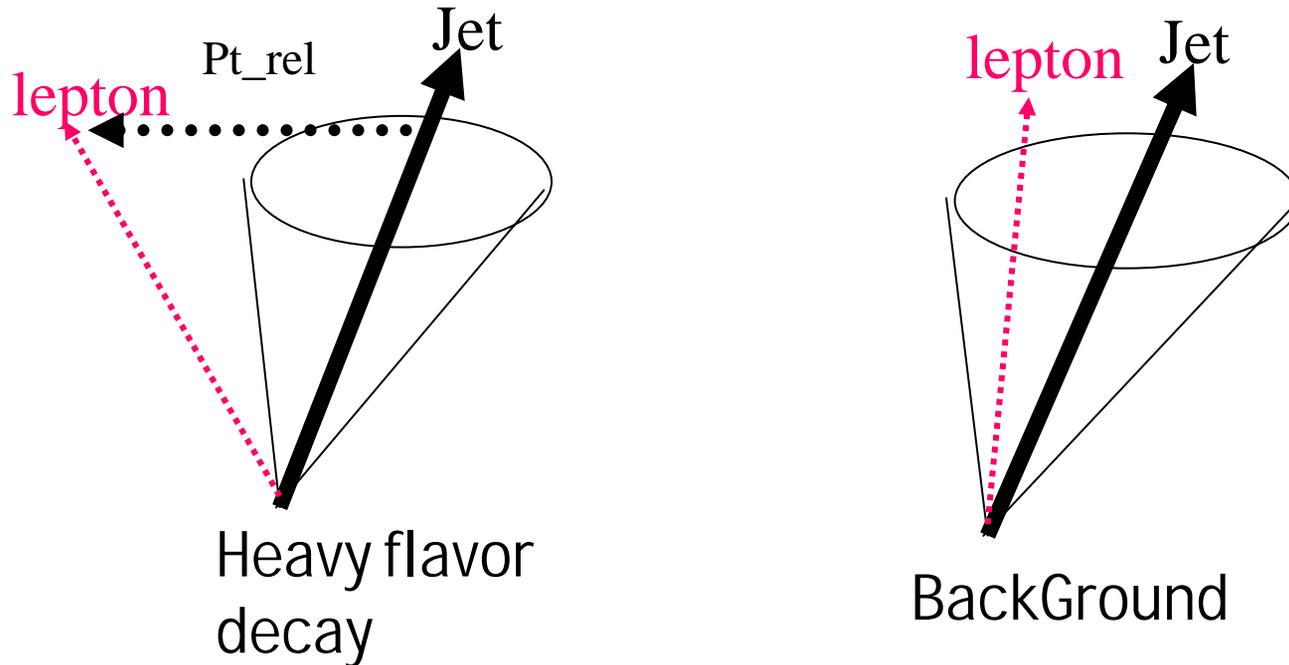


# Forward Calorimeter

1. Basic Concept
2. Jet identification by Forward Cal.
3. B tagging
4. Effect Muon detector
5. Calorimeter hardware and Cost

# Basic Concept



Heavy Bottom Mass  $\rightarrow$  Larger Isolation from Jet axis

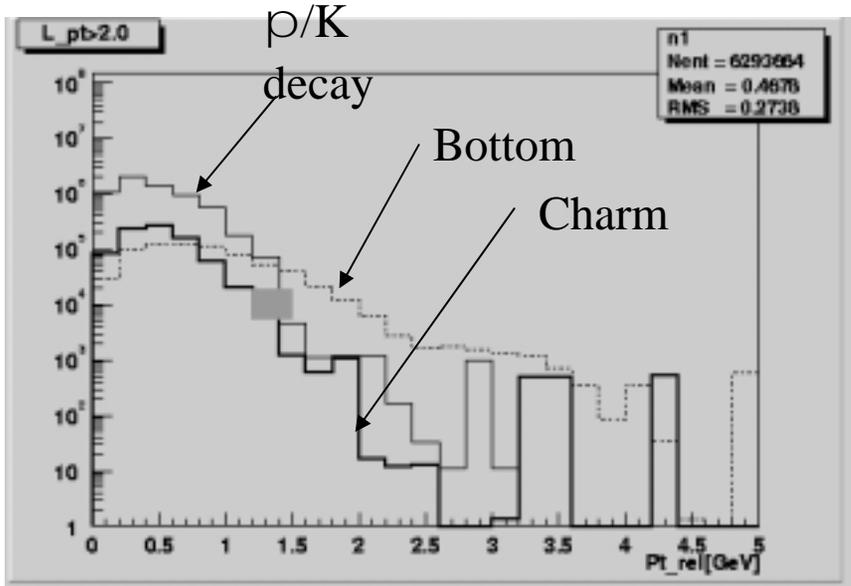
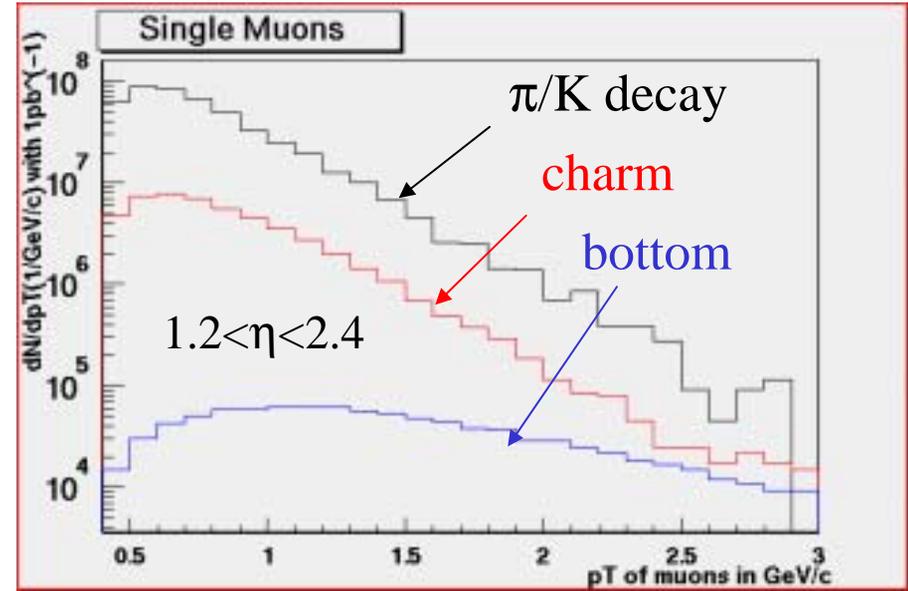
Q value  $B \sim 1.5 \text{ GeV}$

$C \sim 0.5 \text{ GeV}$

# Previous Study

$p+p, \sqrt{s}=200\text{GeV}, \text{PYTHIA+GRV94-LO}$

- Current configuration  
 $Pt(m) > 6\text{GeV}$   
 $S/N \ 0.4, \text{QCD } 44\text{k}, \text{C } 2.3\text{K}, \text{B } 14\text{K}$   
 It is not so easy to tag heavy quark.



$Pt\_rel[\text{GeV}]$

A.Taketani, RIKEN Mar 2001

- Ideal case ( $|h| < 3, \text{EMCAL+HADCAL}$ )
- $Pt(m) > 2\text{GeV}, \ Pt(m)_{\text{Jet}} > 1.5\text{GeV}$   
 $S/N \ 12, \ \text{QCD } 4.7\text{K}, \ \text{C } 3.2\text{K}, \ \text{B } 53\text{K}$   
 Single Muon Physics seems OK.

# Jet identification by Forward Cal.

## Specification

Coverage  $1.1 < |\eta| < 2.4$ ,  $2\rho$  in  $f$  S@Z=40-60cm

Electromagnetic Calorimeter

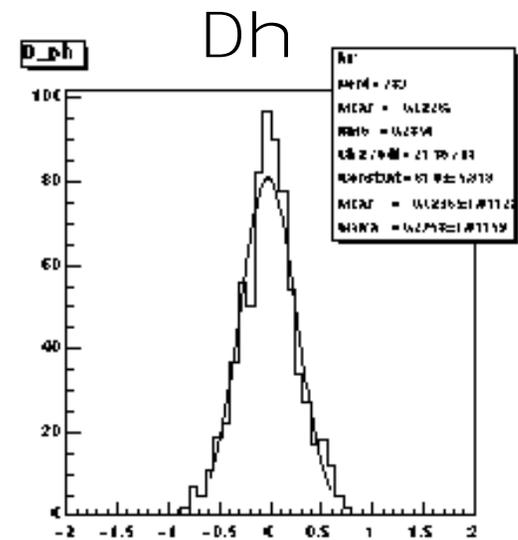
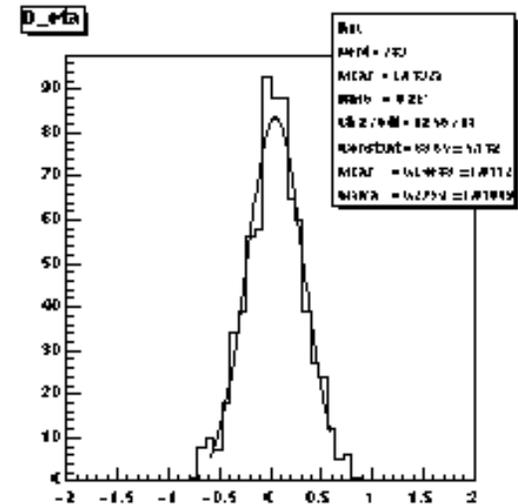
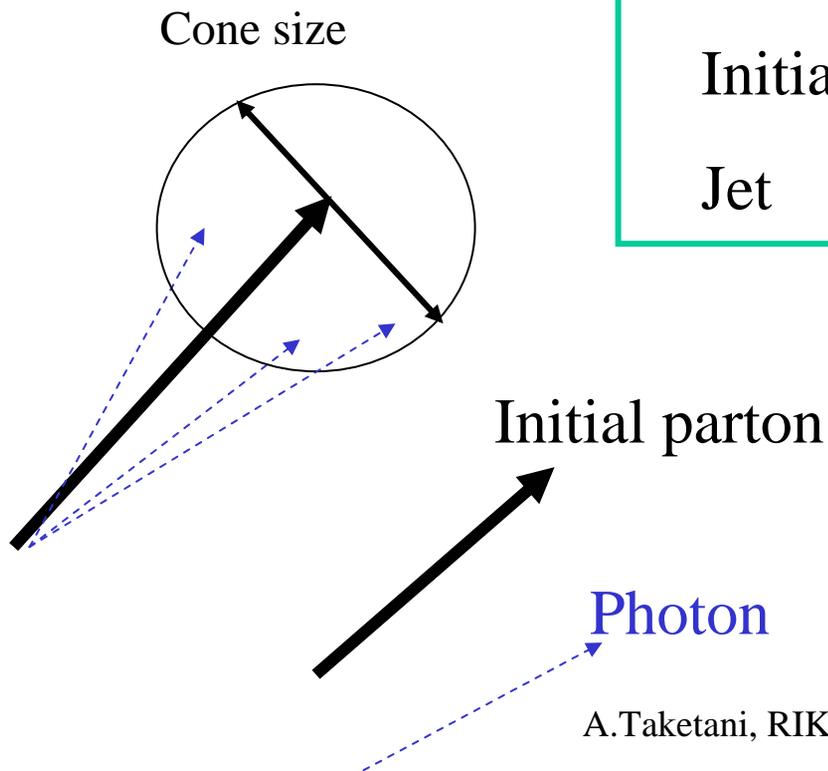
Granularity  $\rightarrow$  perfect to 0.15

Energy resolution  $\rightarrow$  perfect to  $0.4 * \text{SQRT}(E)$

Can We see Jet in Forward Cal?

# Cheating Cone Algorithm

$$\vec{JET} = \sum_{Cone} \vec{Photon}$$



# Kt Jet algorithm

## Reference RUNII Jet Physics hep-ex/0005012

1. Define Precluster

$$d_i = p_{T,i}^2$$

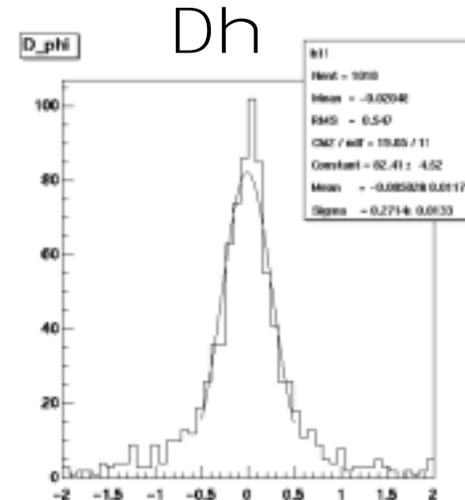
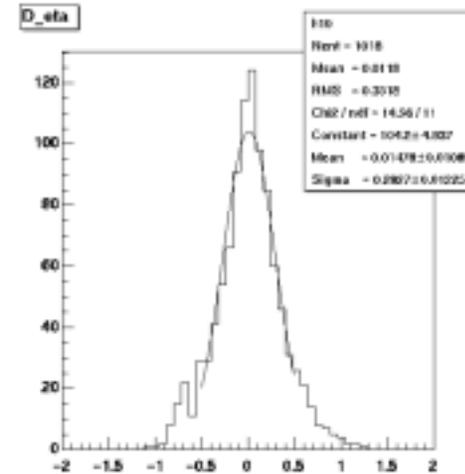
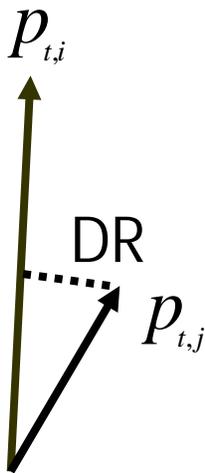
$$d_{ij} = \min(p_{T,i}^2, p_{T,j}^2) \frac{\Delta R^2}{D^2}, \Delta R < D, D \equiv 1$$

2. Find minimum d

if it is single precluster, identify as Jet

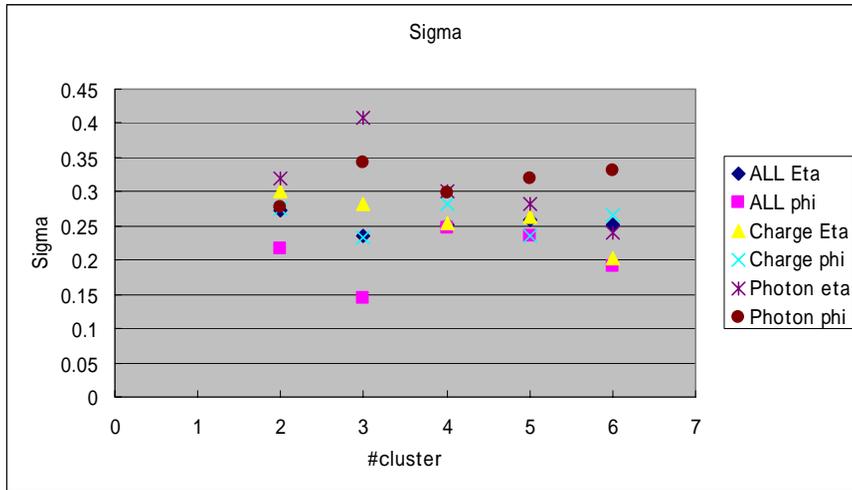
if not, merge two precluster into a new precluster

3. Repeat until no precluster remain

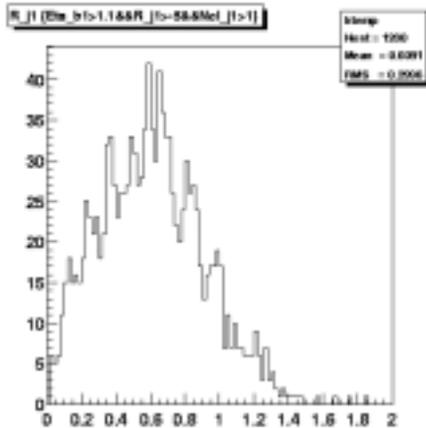
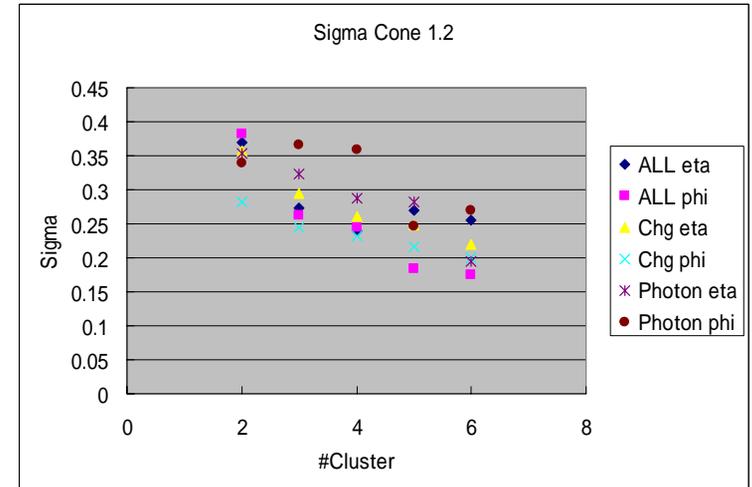


# Comparison with Kt-Cone

Kt-Jet



Cone



Resolution of Eta-Phi matched with Cone!

Kt-jet can identify jet axis in Forward EM-CAL

Most Distant cluster @Kt-jet

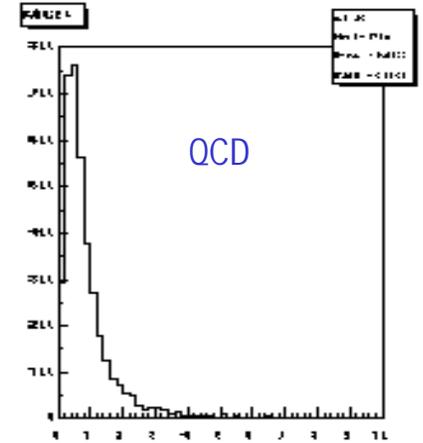
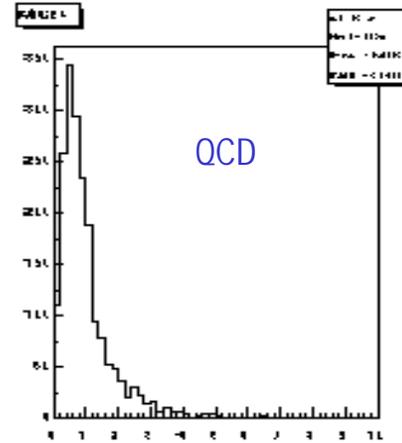
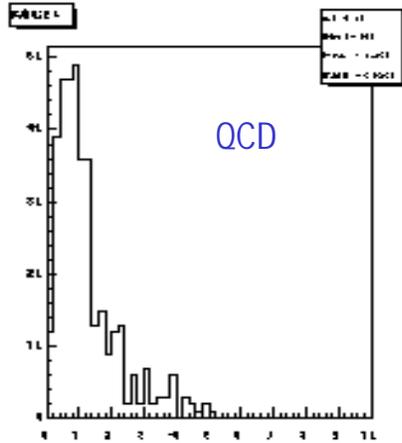
# Pt from Jet Axis

5 < Pt\_parton < 10 GeV

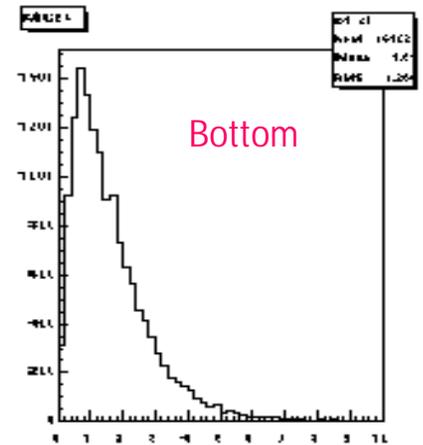
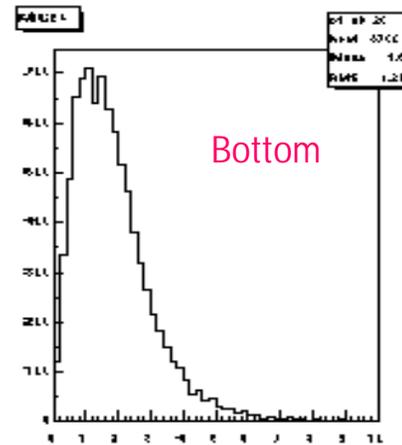
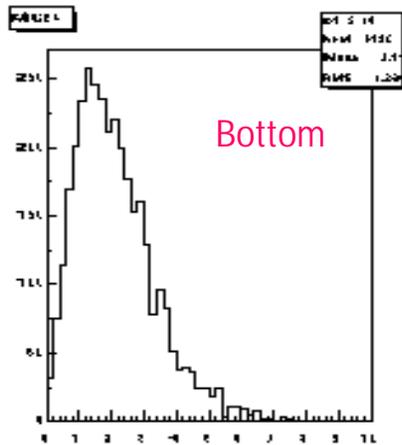
10 < Pt\_parton < 20 GeV

20 GeV < Pt\_parton

Forward only  
 0.05\*0.05 in  $\eta - \eta$   
 No resolution smearing  
 Not normalized yet.



Pt\_beam (Muon) > 2 GeV  
 P(Muon) > 2 GeV  
 Et\_jet > 1 GeV  
 #Hit\_jet >= 4

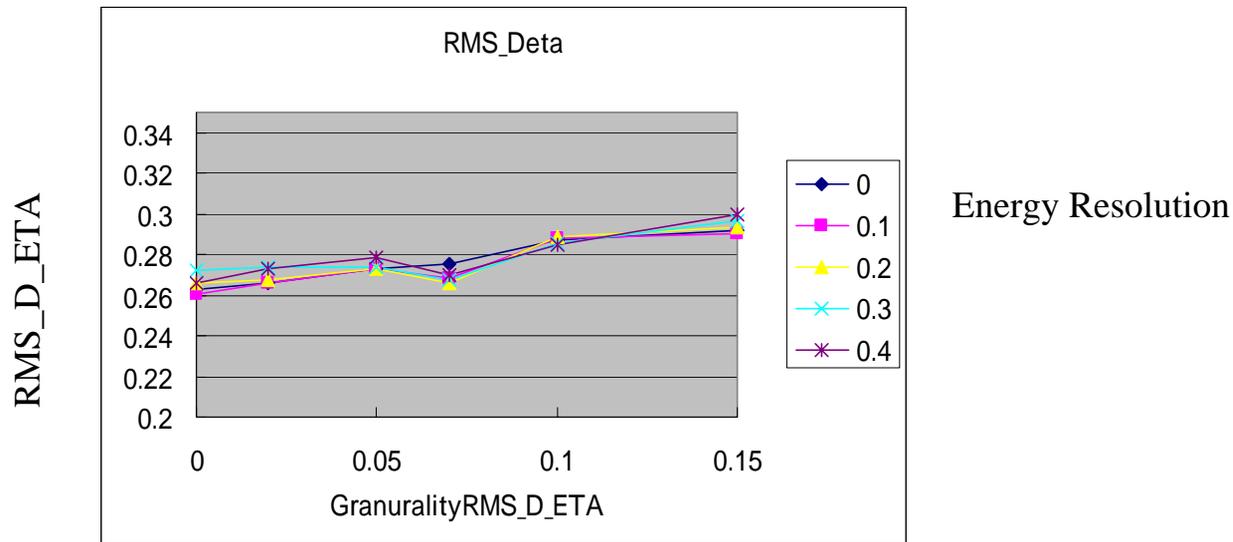


0 10

0 10

0 10

# Granularity/Energy Resolution



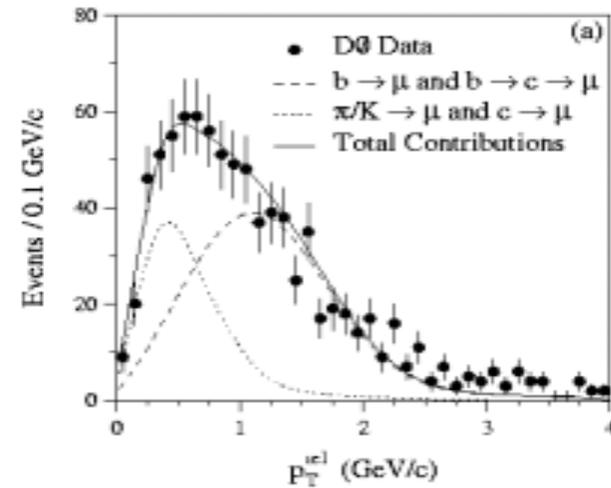
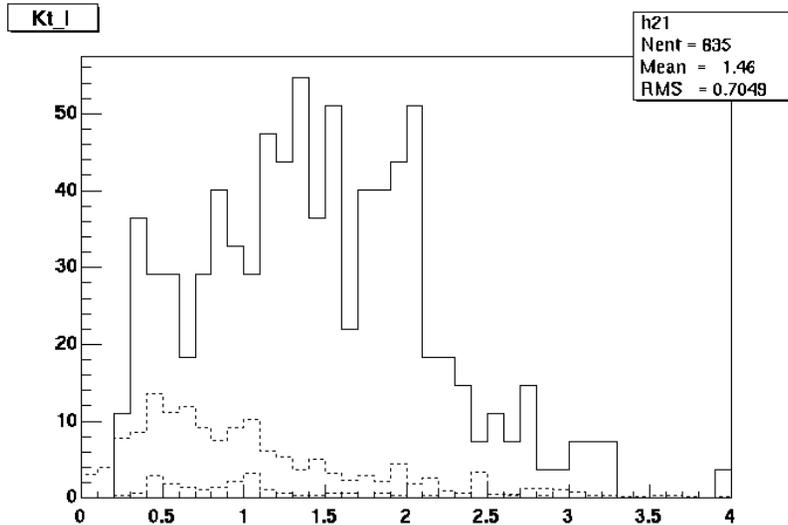
Detector granularity

Detector Granularity affects the Jet axis direction measurement.

Energy resolution affects small.

# DZERO

Phys. Rev. Lett. 74 (1995) 3548



PYTHIA + Kt Jet Finding

Algorithm is working.

$|y_{\mu}| < 1.0$

$P_{t,\mu} > 8 \text{ GeV}$

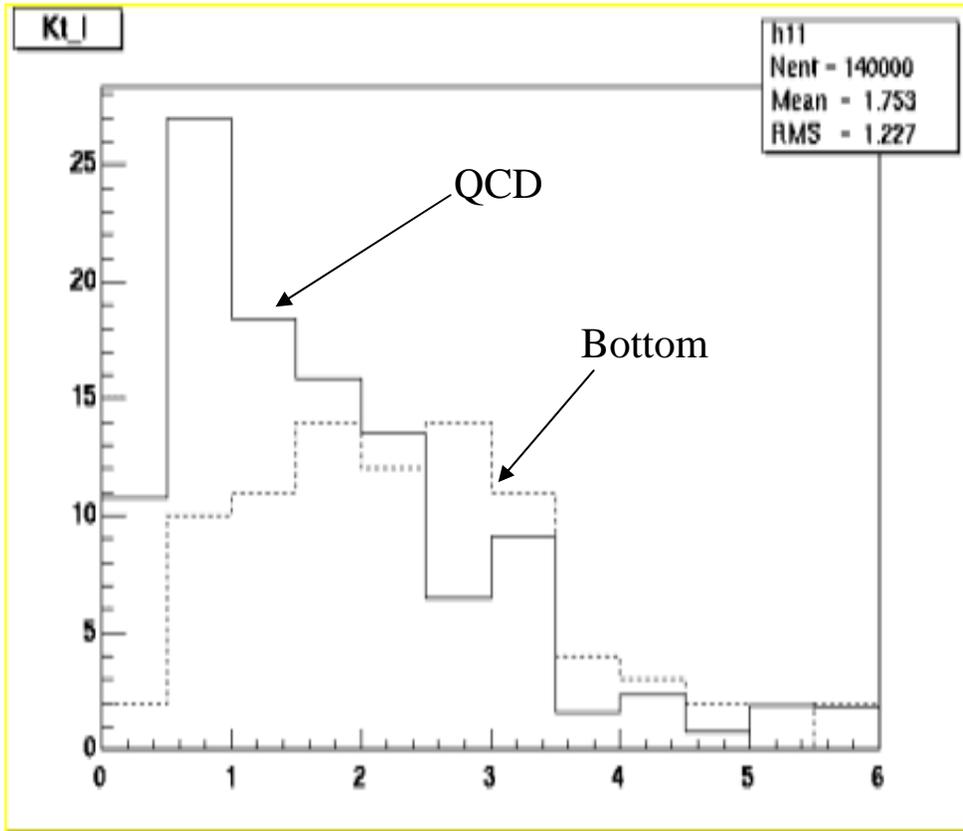
$E_{t,\text{jet}} > 8 \text{ GeV}$

$L = 73 \text{ nb}^{-1} @ 1.8 \text{ TeV}$

# Effect to Muon resolution

- Use N.Saito and M.L.Brooks 's momentum resolution parameterization (PHENIX-muon95-8)
- Compare nose cone material.
  - Cu(20cm) 14X0, 1.3| |
  - W(15cm) 43X0, 1.6| |
- Look at J/Psi mass resolution.

# Pt\_relative



PP @ 500GeV

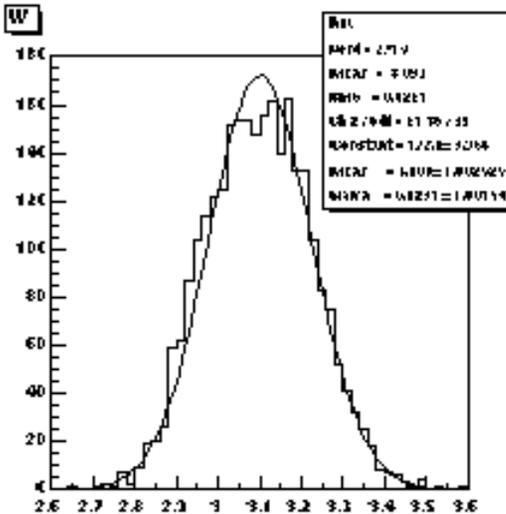
Pt(mu)>5GeV

Et(jet)>1GeV

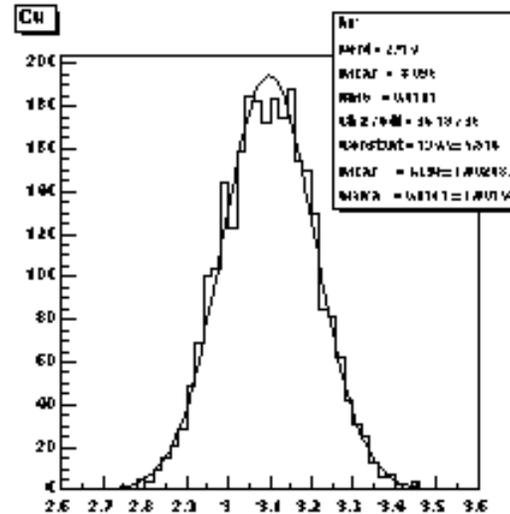
PYTHIA Default

Need to check Yield carefully.

# J/Psi mass resolution



W 123MeV

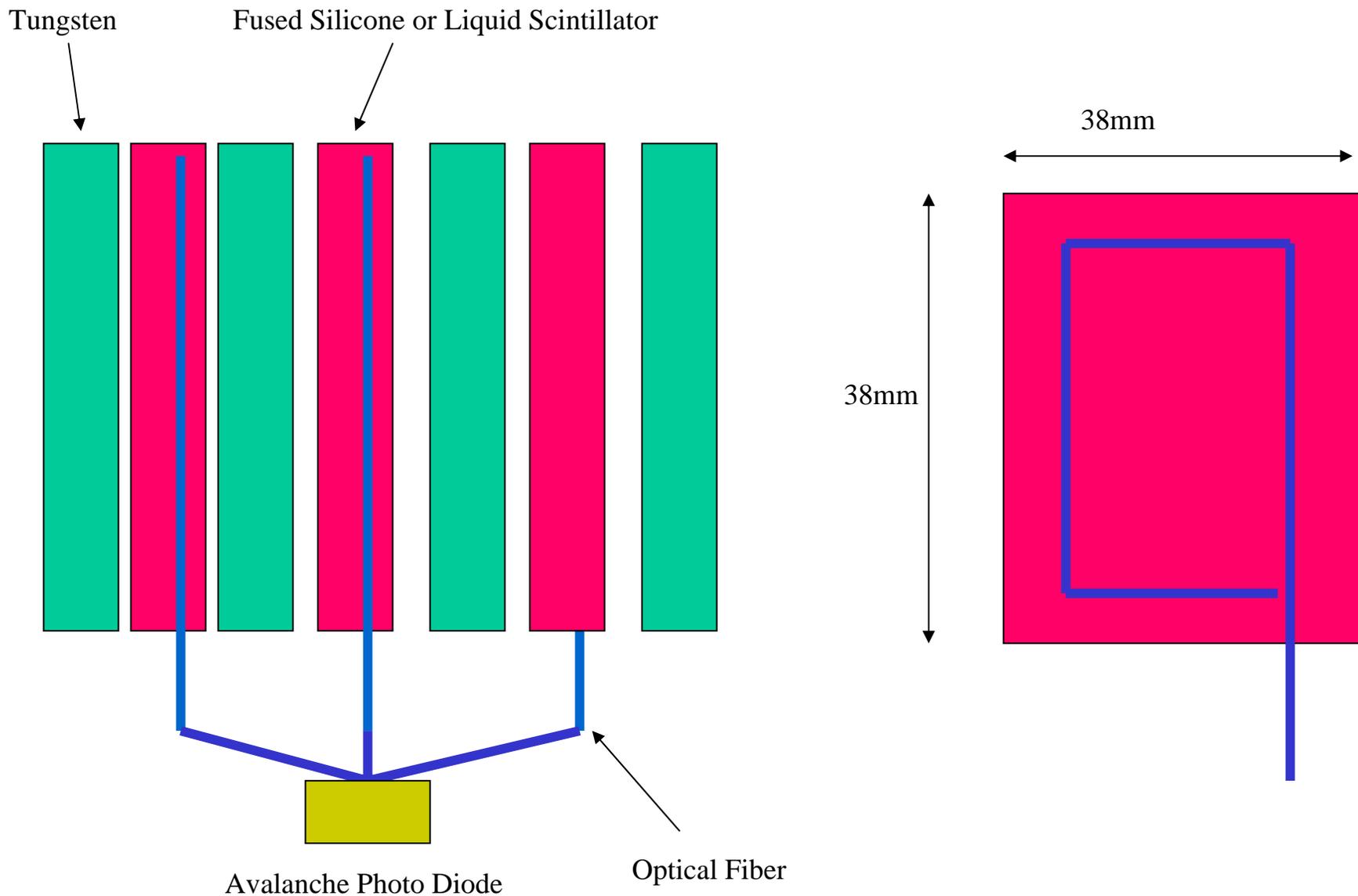


Cu 109MeV

Need to look at U mass resolution.

Need to optimize size of material.

# Calorimeter Idea



# Cost Estimate

Granularity 0.1 in Eta-Phi -> Total Readout 1240ch

38mm\*38mm in average

Readout APD \$50/ch -> \$6K

FEE \$200/ch -> \$24K

Fused Si \$5\*120\*10 -> \$6K

Fiber \$10K

W \$60/Kg \* 4400Kg -> \$260K

Total ~\$300K+R&D ~

\$1M????

(PbWO4 \$500/2\*2\*20cm \*2240 -> \$1.1M)

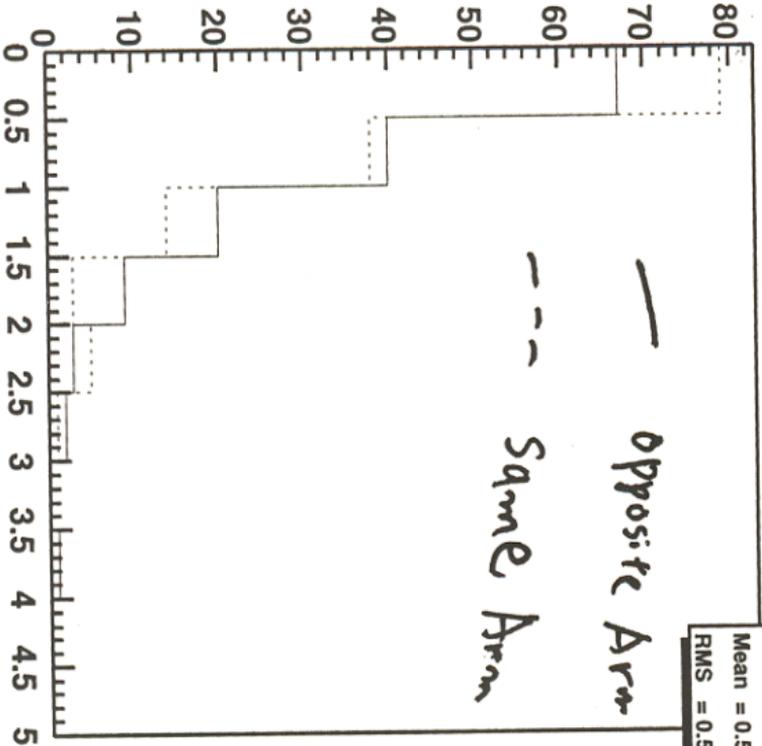
# Summary

- Forward calorimeter can determine jet axis direction and can measure  $P_{t\_relative}(\mu)$ .
- S/N needs more study for Bottom and background yield.
- Need to study W, DY, Trigger, Photon+Jet
- Need idea for H.I. usage.

ETFCAL

W

h11  
Nent = 143  
Mean = 0.5628  
RMS = 0.5584

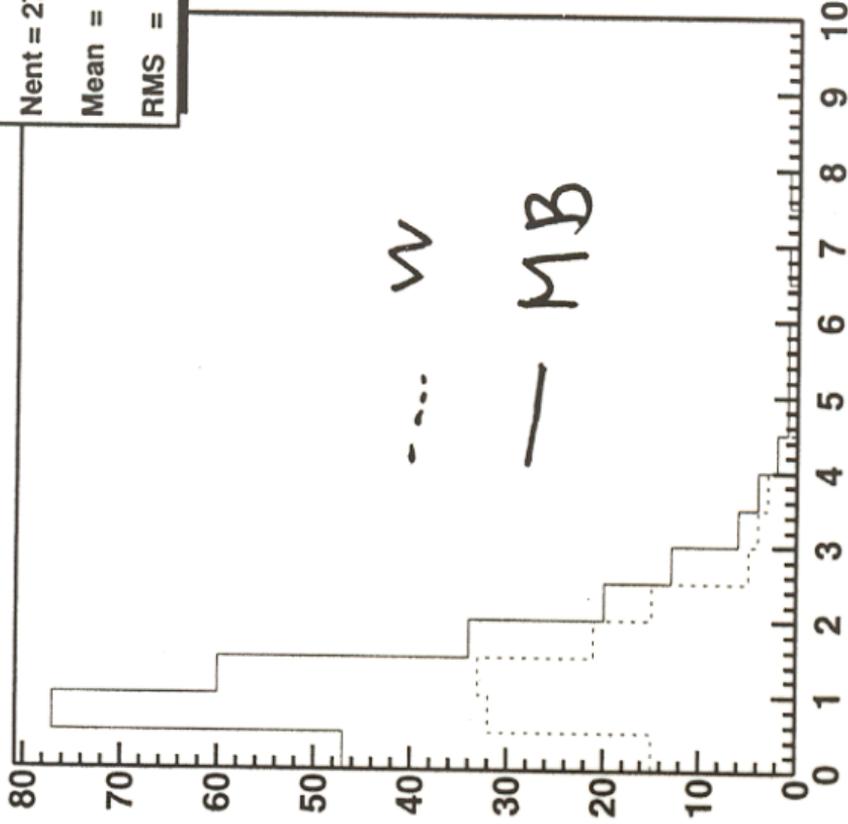


— Opposite Arm

- - - Same Arm

**EtFCAL**

h10  
Nent = 274  
Mean = 1.34  
RMS = 1.05



# Cherenkov Counter

- Threshold type  
M.B. events are dominated by lower momentum  
~5 GeV
- Between station2 and station3 or front of MUID  
Only available space
- CO<sub>2</sub> is good radiator  
Number of photons is similar to RICH electron  
Radiation length is 0.5%. Station 2 radiation length is 0.1%.  
CO<sub>2</sub> bag for PP high luminosity run?